

SOLAR – THE ROAD UNEXPLORED



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India continues to champion solar power in its future plans of a 500 GW non-fossil fuel energy installation target for 2030. One major challenge is the procurement of suitable land free of socio-ecological constraints for renewable energy capacity. An innovative solution is the integration of solar PV systems either along the side of roads or above (highway solar) or directly on their surface (on-road solar). These approaches have the potential to be utilized on all national highways and expressways.

Highway solar places solar PV systems either along the guard rails, the divider of the road, or placed in an elevated position covering the highway. This effectively utilizes the available vacant land, which is already procured for infrastructure. The system can be modeled to generate electricity for the entire stretch, thereby serving multiple uses. This design would have similar efficiency levels to that of ground-mounted systems, the only difference being a higher level of exposure to dust particles. This is a long-term investment, which is ideal for locations with extensive road networks, scarcity of conflict-free land, and high solar insolation.

On-road solar integrates PV panels onto the road surface. This consists of the base layer of bitumen (asphalt) upon which the PV module is attached through an adhesive. Additional glass layers (for supporting the impact load) and transparent anti-skid layers are added above the PV module. The solar panel efficiency itself is directly dependent on the panel type used, but the effective capacity factor is also highly dependent on local factors such as irradiation, shading, the volume of vehicular traffic, thermal performance, etc.

These designs can essentially integrate solar PV into existing infrastructure where the electricity generated can be used to charge electric vehicles, and provide street lighting and shading of roads. They can also act as noise barriers when set up along city limits. Despite these advantages, the initial capital cost would be higher than usual owing to the modified linear design. On-road solar, in particular, costs INR 33,750 - 1.3 Lakh per m² in pilot projects, far higher than the INR 1,500 - 7,500 per m² for asphalt roads. These technologies also face increased maintenance costs, concerns of panel theft, and multiple environmental factors that could affect the structural integrity of the road.

The Ministry of Road Transport and Highways announced plans to install solar PV systems on any viable unused land not allotted for transport, highway-related services, or plantation. A similar modeling study, placing solar panels above the highway along with the Golden Quadrilateral highway network (spanning 5,839 km), estimated a capacity of 4,418 MW. A 2017 project in China aimed to produce 1 GWh annually from on-road solar on a 1 km stretch. Given the extensive network of national highways in India (1.4 lakh kilometres), there is significant potential for large-scale RE generation.

A large-scale deployment requires tremendous technical advancements, policy guidance, and sustained financial support. The cost of implementing these technologies is higher than conventional solar power projects and requires initial backing to disseminate into the market. To achieve this, the first step is further research and implementing pilot projects to address the numerous technical concerns. A cautious approach is required to evaluate these technologies, as the potential is too large to be ignored and warrants a deeper study.